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Review

Effective interventions for preventing work related physical health complaints in nursing students and novice nurses: A systematic review

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ABSTRACT

From the start of their career, nursing students and novice nurses are at risk of developing physical health problems due to high physical workload, which may lead to early exit from nursing. To provide an overview of interventions preventing physical health problems in early career, a systematic review was performed. A comprehensive search of the literature was conducted up to December 2017. Primary outcome of interest was education/work dropout. Secondary outcomes were musculoskeletal symptoms. Independent authors selected studies, appraised quality and extracted data. After screening 7111 titles and abstracts, eleven studies were included. Seven studies evaluated interventions for moving/handling training. Four evaluated other interventions. None focused on our primary outcome education/work dropout. All studies reported on physical complaints among student nurses only. Overall, risk of bias was high and clinical heterogeneity prohibited pooling of data. Intervention effects were small and inconsistent. In conclusion, evidence for the effectiveness of interventions in the nursing curricula for the prevention/treatment of physical complaints is scarce and where available conflicting. We recommend high quality research on dropout due to physical health problems, as well as on the prevention/treatment of physical complaints.

1. Background

Nurses, as well as many other health professionals, frequently have to deal with a high physical workload, including lifting while transferring a patient, awkward working postures during patient care, and pushing/pulling while repositioning a patient or manoeuvring equipment, often leading to complaints of the neck, shoulder and back (da Costa and Vieira, 2010; Garg and Owen, 1992; Koppelaar et al., 2012; Smedley et al., 1995; Warming et al., 2009).

Apart from graduated nurses being at risk to develop musculoskeletal problems, musculoskeletal problems are also prevalent in the nursing student population (Smith and Leggat, 2004; Mitchell et al., 2009). Smith and Leggat (2004), for example, investigated the prevalence of musculoskeletal problems among rural Australian student nurses and found that 80% of students reported musculoskeletal problems at some body site, with low back pain as the most common condition (59.2%). Lövgren et al. (2014) examined neck/shoulder and back pain in newly graduated nurses and reported an increasing trend towards and after graduation. Monitoring research in nursing homes, homes for elderly and home care services sectors in the Netherlands, showed that especially young employees, including students, have greater risk. Compared to older employees, they have up to 10% more musculoskeletal complaints (de Vries et al., 2011).

Musculoskeletal symptoms lead to productivity loss at work, sick leave, or even turnover from health care, from the nursing profession (Andersen et al., 2014; Bos et al., 2006; de Jong et al., 2014; Fochsen et al., 2006; Mazurenko et al., 2015), or from nursing education (Lövgren et al., 2014; Smith and Leggat, 2004).

Many preventive and therapeutic interventions for musculoskeletal conditions in experienced registered nurses are available. Examples of a wide range of preventive measures in the workplace, such as preferred patient handling techniques and the use of lifting devices, were

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described in various studies (Bos et al., 2006; de Jong et al., 2014; Hamer and Timmerhuis, 2014; Koppelaar, 2013). Koppelaar (2013, 2012)presented an overview of primary preventive interventions to reduce the exposure to manual patient handling, e.g. lifting techniques, ergonomic devices, rapid self-appraisal methods to evaluate mechanical load, and the introduction of so-called 'ergocoaches'. Nevertheless, such interventions are under-utilised in daily practice (Bos et al., 2006; Cornish and Jones, 2007; de Jong et al., 2014; Hamer and Timmerhuis, 2014; Koppelaar, 2013). Potentially, the implementation of effective preventive and curative interventions may (partly) decrease the occurrence of back complaints.

Concurrently, it would be effective to implement preventive strategies during nursing education to reduce the high prevalence of pain in this population, and enable them to continue nursing work after graduation (Lövgren et al., 2014); the authors, however, also state that strategies for managing these conditions should be developed and provided at the same time, suggesting that effective preventive strategies may not be available yet. In addition, nursing schools do not seem to prioritize (ergonomic) measures to prevent dropout and/or the onset of physical health problems resulting from high physical working demands (de Vries et al., 2011); implementation of these interventions seems difficult to achieve. Interventions aimed at the prevention of musculoskeletal problems in student and novice nurses, however, may contribute to the physical resilience and retention of these groups.

To our knowledge, there is no systematic evidence supporting the effectiveness of interventions focused on dropout from nursing education or the nursing profession due to musculoskeletal problems. Moreover, it seems justified and equally important to identify interventions that are effective in preserving physical health in student and novice nurses, since musculoskeletal problems may contribute as early indicators of dropout.

Therefore, this review examined interventions implemented in nursing schools aimed at physical health problems among student or novice nurses. The implementation of effective interventions in nursing schools may result in a decrease of physical health problems and can contribute to the retention of student nurses in nursing education and novice nurses in the nursing profession.

This review aimed 1) to provide an overview of interventions available for student or novice nurses with a focus on their physical health and wellbeing and the effect of these interventions on the prevention of dropout and 2) to provide an overview of the effect of these interventions on physical health problems.

2. Methods

2.1. Design

With this systematic review we systematically and comprehensively searched, appraised and synthesised research evidence (Grant et al., 2009) for interventions aiming at the prevention of dropout of student or novice nurses from nursing education or the nursing profession, respectively, due to physical health problems. We used the Cochrane handbook (Higgins and Green, 2011), the recommendations by the Editorial Board of the Cochrane Collaboration Back Review Group (van Tulder et al., 2003) and followed the PRISMA 2015 guideline (Moher et al., 2009; PRISMA, 2015) to ensure consistency and rigorousness.

2.2. Outcomes

The primary outcome of interest was dropout from nursing education, or from the nursing profession in the first two years after graduation, due to musculoskeletal symptoms or discomfort. Data on dropout could be self-reported or registry based.

The secondary outcome was the prevalence of musculoskeletal symptoms or discomfort in students and/or novice nurses, whether self-reported or clinically diagnosed by a physician.

We included studies describing interventions in the educational setting for student nurses and/or healthcare setting for novice nurses.

2.3. Types of studies

All studies with a quantitative research design were included, e.g. randomised controlled trials, clinical controlled trials, pre-post intervention studies, and observational studies. We also included studies with a mixed-method design and articles published in any language. For languages of the original articles other than English, Dutch, German or French, Google translate was used for the first translation of these studies (Balk et al., 2012). If necessary, a professional translator was consulted.

2.4. Participants and types of interventions

Participants were student and/or novice nurses, less than two years after graduation. We were open to any type of intervention as long as the intervention focused on; i) dropout from nursing education or the nursing profession within two years after graduation and ii) musculoskeletal problems.

2.5. Literature search and selection

The CINAHL, EMBASE, ERIC, MEDLINE, the Cochrane Library, Web of Science, and Google scholar databases were searched from inception up to December 18, 2017 (Bramer et al., 2017): To identify possible studies for this review, detailed search strategies were developed for each database by an information specialist of Erasmus University Medical Center Rotterdam. The database-specific search strategies used are available in the online appendix.

A three-step search strategy was built, using 1) relevant terms and synonyms related to the target population (e.g. student nurse, novice nurse), 2) the primary outcome measure (such as dropout, early exit, or turnover), and 3) the type of interventions. Comparable search strategies were used with secondary outcome measure terms. In addition, the reference lists of the included publications and six additional reviews were scrutinised to identify potentially relevant studies that might have been missed. Because a first orientation in the literature suggested that relevant publications might be scarce, we set no limit to the publication date.

Two authors (JK, EB) independently screened all titles and abstracts using Covidence software (Covidence, 2017). For all potentially relevant studies, full-text copies were retrieved and assessed. Any disagreements were resolved by consensus, or a third author (PR) was consulted if disagreement persisted.

Studies were included if the primary outcome was reported or could be calculated as the number of dropped out student/novice nurses per year, or reported a secondary outcome (e.g. musculoskeletal symptoms).

2.6. Quality appraisal, data extraction and data syntheses

The methodological quality of the included articles was individually assessed by three reviewers (JK, PR and JR) using the Cochrane Risk of Bias tool (modified) for quality assessment of RCTs (Higgins et al., 2011). The results of these three independent reviewers were compared and consensus on risk of bias was reached in a joint discussion.

We retrieved the following data: 1) characteristics of the included studies, e.g. country, number of participants, design, evaluation method, results, outcomes, 2) characteristics of the interventions, e.g. duration, target group characteristics (age, sex, year of study, work experience, ethnic group), components, professionals involved, and 3) outcome measures.

Clinical and statistical heterogeneity were assessed for all included studies that reported similar outcomes. The trials were assessed based

on setting, participants, and intervention. If trials were clinically heterogeneous, data were not pooled. Statistical heterogeneity was assessed with the Chi-square test and I-square statistics. If I-square values were ≥50%, substantial heterogeneity was deemed present (Higgins et al., 2011).

It was planned to use funnel plots to investigate reporting bias if at least four trials were included in a specific comparison. Where appropriate, it was planned to pool the results of comparable studies and report the pooled estimates, together with the 95% confidence interval (CI). However, due to practical/clinical and methodological heterogeneity of the included studies, statistical pooling was not feasible. Therefore, results are described from the qualitative data synthesis (clinically comparable studies).

3. Findings

3.1. Search results

The electronic searches for this review identified 12,533 references. After removing duplicates, 7111 records remained for screening. Based on the title and abstract, 7040 records were excluded, leaving 71 potentially relevant abstracts. For these, the full-text articles were retrieved. Of these 71 studies, 60 were excluded because they did not fulfil the inclusion criteria. Fig. 1 presents an overview of the inclusion/exclusion process (with reasons for exclusion). Scrutinising the reference lists of six reviews (Bernal et al., 2015; Clemes et al., 2010; Davis and Kotowski, 2015; Dawson et al., 2007; Tveito et al., 2004; Yassi and Lockhart, 2013) and of all the included articles did not yield any additional studies. Finally, 11 studies matched the inclusion criteria and were included in this review. These 11 articles described 12 interventions.

3.2. Characteristics included studies

Of the 11 studies, three were RCTs (Kim and Park, 2006; Svensson et al., 2009; Tooms et al., 1987); one had a quasi-randomised controlled design (Yazdani et al., 2014); one described two interventions (one with a non-randomised controlled design and one with an observational design) (Stubbs et al., 1983); another study had an observational design (Costa et al., 2011); and the remaining five studies were non-randomised controlled studies (Gladman, 1993; Hellsing et al., 1993; Moens et al., 2002; Troup and Rauhala, 1987; Videman et al., 1989). Of all studies, 10 concerned 'nursing students' and one (Svensson et al., 2009) focused on 'assistant nursing students'; this latter study was included since this group was considered to be similar to 'nursing students'. We found no studies reporting on novice nurses.

The sample size of the individual studies ranged from 2 to 668 participants. A total of 1634 participants were included in 10 studies, and one study did not report the number of participants (Costa et al., 2011).

All studies were conducted in nursing schools. The studies were conducted in the UK (Gladman, 1993; Stubbs et al., 1983), Sweden (Hellsing et al., 1993), Belgium (Moens et al., 2002), Denmark (Svensson et al., 2009), Finland (Troup and Rauhala, 1987; Videman et al., 1989), Portugal (Costa et al., 2011), Korea (Kim and Park, 2006), USA (Tooms et al., 1987), and Iran (Yazdani et al., 2014). Table 1 summarises the characteristics and main results of the primary and secondary outcomes of the included studies.

3.3. Interventions included in studies

Seven studies investigated interventions aimed at ergonomic training and included: a course on lifting and moving patients (Gladman, 1993); ergonomic and behavioural training (Hellsing et al., 1993); lifting and transfer techniques (Moens et al., 2002); moving patients up a hospital bed (Stubbs et al., 1983); multidimensional low back pain prevention programme (Svensson et al., 2009); additional patient handling training (Troup and Rauhala, 1987); and biomechanics and ergonomics training (Videman et al., 1989).

Four studies focused on other intervention types: applying changes in the cafeteria space, verifying the substitution of elements of furniture, pavement and luminosity (Costa et al., 2011); exercise program (Kim and Park, 2006); effect of viscoelastic shoe inserts (Tooms et al., 1987); and laughter Yoga (Yazdani et al., 2014).

3.4. Reported outcomes

None of the included studies reported on dropout related outcomes, our primary outcome of interest. Nine studies reported on back pain, with only two studies focusing on back pain at work alone (Gladman, 1993; Hellsing et al., 1993). Other studies examined back pain as reason for sick leave (Moens et al., 2002; Svensson et al., 2009), intra-abdominal pressure (Stubbs et al., 1983), patient handling (Troup and Rauhala, 1987; Videman et al., 1989), working posture (Costa et al., 2011; Troup and Rauhala, 1987), and post work pain (Tooms et al., 1987). One examined body composition and physical fitness (Kim and Park, 2006). Another explored general health and physical disorders (Yazdani et al., 2014).

3.5. Quality appraisal and methodological considerations

The methodological quality of the 11 studies is presented in Fig. 2 and a summary of the 'risk of bias' assessment of each item across trials is provided in Fig. 3. All studies were considered to have a high risk of bias.

The variety in methods used was high. The data of the 11 studies could not be pooled, because of the heterogeneity of the interventions, the different comparators and the differences in timing of measurements. Rationales for chosen design were poorly described and discussed.

Studies were non-blinded to the participants nor to the providers of the interventions, and all outcomes were self-reported. Because most studies did not adequately describe the randomisation procedure, it was not possible to determine whether adequate procedures were used. The study populations ranged from 2 to 668 (mean = 178, median = 87) participants; the small sample size of some studies resulted in a lack of statistical power to detect relevant effects of these interventions.

3.6. Effectiveness of patient handling interventions

Six studies (Gladman, 1993; Hellsing et al., 1993; Moens et al., 2002; Svensson et al., 2009; Troup and Rauhala, 1987; Videman et al., 1989) evaluated a curriculum-based training for safe patient handling in nursing schools to reduce musculoskeletal symptoms. Although patient-handling techniques improved significantly in the intervention groups in three of the studies (Moens et al., 2002; Troup and Rauhala, 1987; Videman et al., 1989), no decrease in musculoskeletal symptoms (back pain) was found. Svensson et al. (2009) did not report on improvements in patient-handling techniques, nor on a decrease in musculoskeletal symptoms. Two studies found a statistically significant difference in the prevalence of back pain in favour of the control group (Gladman, 1993; Hellsing et al., 1993).

Stubbs et al. (1983) found no relationship between the time spent training in patient transferring techniques and prevalence of back pain. Moens et al. (2002) studied the incidence of back pain as reason for sick leave, but found no statistically significant effect between the intervention and control groups.

Table 2 presents the results of a descriptive comparison between studies with a similar ergonomic intervention that reported the effects on the prevalence of back pain (trials did differ on pain measurement scales and time points). Table 2 shows that, based on the change in baseline prevalence, three of five studies (Gladman, 1993; Moens et al.,

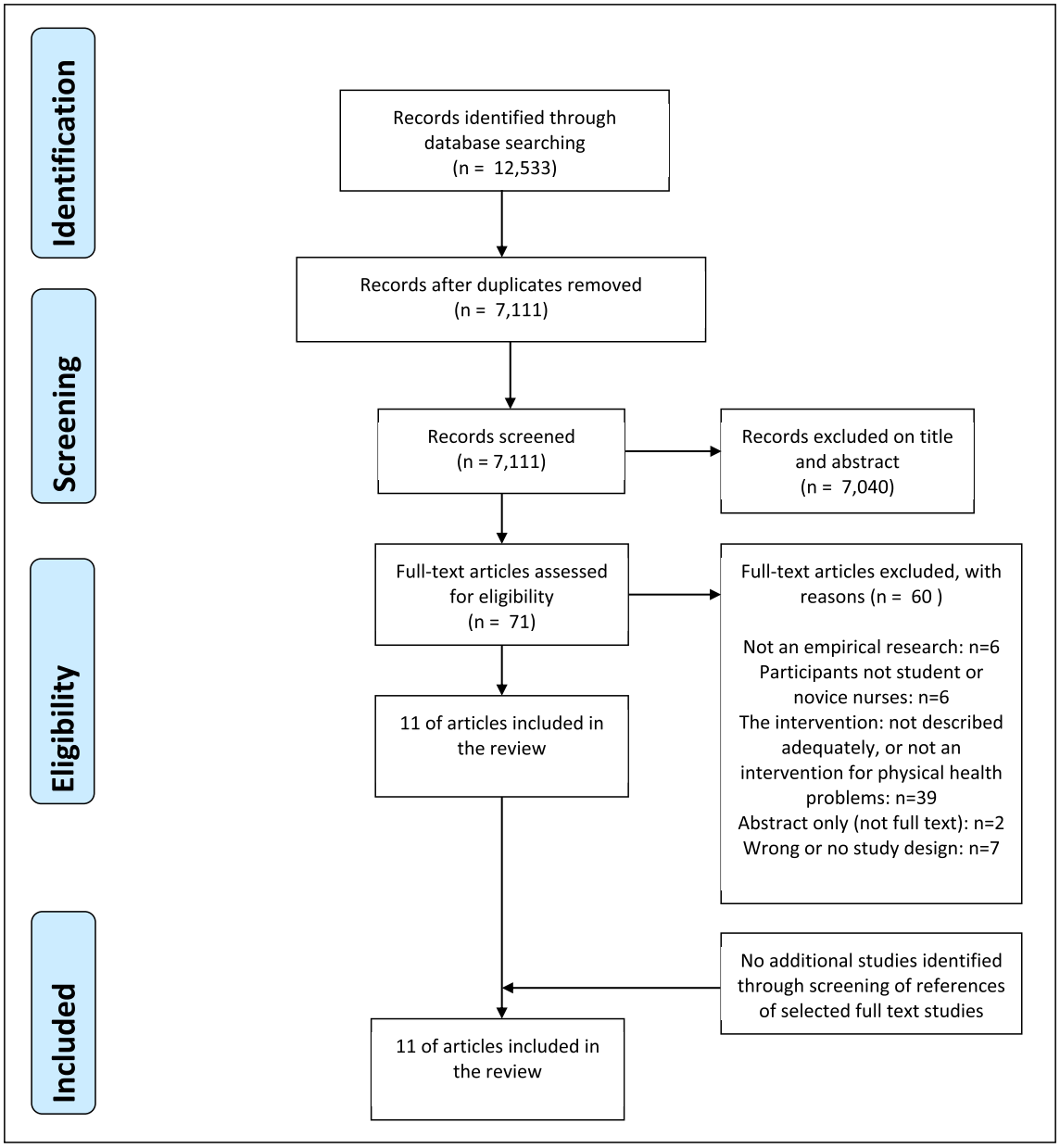
Identification
Screening
Eligibility
Included
Records identified through database searching (n = 12,533)
Records after duplicates removed (n = 7,111)
Records screened (n = 7,111)
Records excluded on title and abstract (n = 7,040)
Full-text articles assessed for eligibility (n = 71)
Full-text articles excluded, with reasons (n = 60)
Not an empirical research: n=6
Participants not student or novice nurses: n=6
The intervention: not described adequately, or not an intervention for physical health problems: n=39
Abstract only (not full text): n=2
Wrong or no study design: n=7
11 of articles included in the review
No additional studies identified through screening of references of selected full text studies
11 of articles included in the review

Fig. 1. Flow diagram of the inclusion and exclusion of articles for interventions on physical health problems in student and novice nurses.

2002; Videman et al., 1989) had an outcome which favoured the intervention. One study showed no clear difference (1%) between the intervention and control group (Svensson et al., 2009), and another favoured the control group (Hellsing et al., 1993). Clinical/-practical heterogenity prohibited further pooling of data.

3.7. Effectiveness of other interventions

Despite that Costa et al. (2011) found a positive relation between the ergonomic modifications of the nursing school cafeteria and the adoption of more appropriate postures among the users (student nurses) of the cafeteria, they concluded that other conditions that constitute risk factors for musculoskeletal disorders need to be considered.

Tooms et al. (1987) described a statistically significant decrease of back pain/pain in the lower extremity and a shift in pain from back to the lower extremity, only in the intervention group (using viscoelastic shoe inserts).

4. Discussion

This review aimed 1) to provide an overview of interventions available for student or novice nurses with a focus on their physical health and wellbeing and the effect of these interventions on the prevention of dropout and 2) to provide an overview of the effect of these interventions on physical health problems. A review focusing on these two groups was considered necessary due to the unique nature of these particular target groups. Compared with the older, more experienced nursing population, these groups have greater risk to develop physical health complaints (de Vries et al., 2011). Moreover, (intention to) dropout from nursing education or from the nursing profession within two years after graduation is an increasing problem. Worldwide more nurses are needed than are graduating (Kukkonen et al., 2016; Flinkman et al., 2013). Surprisingly, none of the studies included dropout related outcomes and no study focused on musculoskeletal problems in novice nurses. This shows that there is lack of attention for this important issue and stresses the urgency for more research in this important field.

Table 1
Characteristics of the included studies.

First author (year), *(language)*, Country	Study design	Population:Student nurses*	Intervention	Comparison	Outcome of interest	Results
Studies with focus on moving/handling training						
Gladman (1993) *(English)*UK	Non-randomised controlled study	n = 87; Control group(n = 46),Intervention group (n = 41)	Research based patient-handling training	Traditional patient-handling training	Back pain	Intervention group experienced more back pain (92%) than control group (73%) (p = 0.05)
Hellsing et al. (1993) *(English)*Sweden	Non-randomised controlled study	n = 52; Control group(n = 33),intervention group (n = 19)	Ergonomic training package with behavioural training, and extra education on patient handling, besides the regular programme	Regular programme	Back pain frequency and intensity	In the intervention and control groups, low back pain score decreased during the 2-year study and returned to pre-test levels in both groups in the third year. The decrease in lower back pain frequency (p = 0.0352) was statistically significant in the control group during the study. No other statistically significant differences between the groups.
Moens et al.(2002) *(English)*Belgium	Non-randomised controlled study	n = 552; Control group(n = 261),intervention group (n = 291)	Training of lifting and transfer techniques	Regular programme without training	Back pain incidence and sick leave	No statistically significant difference in back pain incidence after 1 year (p > 0.05) and no statistically significant difference in sick leave between the groups (p > 0.05).
Stubbs et al.(1983) A) *(English)*UK	Observational study	n = 8 cross-sectional	Examination of four 2-person techniques for moving a patient up a hospital bed	Not applicable	Back pain prevalence and intra-abdominal pressure	No relation between the time spent training and subsequent prevalence of back pain. Usage of shoulder lift produced statistically significant (p < 0.01) lower intra-abdominal pressure than the other three lifts.
Stubbs et al.(1983) B) *(English)*UK	Non-randomised controlled study	n = 2; Control group(n = 1),intervention group (n = 1)	Practical patient handling training by an experienced teacher during 5 sessions	Training by an experienced teacher was given in session 4 only	Intra-abdominal pressure	Increased intra-abdominal pressure in intervention nurse during turning procedure and use of axillary lift, which reduced during more complex manoeuvres (e.g. transfer of patient from bed to chair). These trends were not observed in the control nurse (not tested).
Svensson et al. (2009) *(English)*Denmark	Randomised controlled study	n = 668 student nursing assistants*; Control group(n = 279),intervention group (n = 389)	Low back pain prevention programme only	Regular programme	Sickness absence and low back pain	Prevalence of low back pain increased in intervention (50%) and control group (53%), but no statistically significant differences. Sickness absence increased in both groups but was statistically significant lower (p < 0.05) in intervention group than in control group.
Troup and Rauhala (1987)(English) Finland	Non-randomised controlled study	n = 199; Control group(n = 93),Intervention group (n = 106)	Additional theory and practical ergonomics and biomechanics patient handling training, besides the regular programme	Traditional patient-handling training	Working posture, patient handling and back pain	No statistically significant difference in prevalence or incidence of back pain after intervention.
Videman et al. (1989) *(English)*Finland	Non-randomised controlled study	n = 200; Control group(n = 113),intervention group (n = 87)	Theoretic and practical ergonomics and biomechanics patient handling training	egular programme	Back pain incidence, severity, injury, disability and patient handling	No statistically significant differences in prevalence or incidence of back pain after intervention (p < 0.001).
Studies with focus on other interventions						
Costa et al. (2011) *(Portugese)* Portugal	Observational study	Data not provided	Ergonomic changes to the physical space and furniture of the cafeteria	Not applicable	Working posture, musculoskeletal disorders	Positive correlation between ergonomic changes and working posture, regarding movement, alignment, posture (musculoskeletal disorders).
Kim and Park (2006) *(Korean)* Korea	Randomised controlled study	n = 56; Control group(n = 28),intervention group (n = 28)	Exercise programme	No exercise programme	Body composition and physical fitness	Statistically significant improvement of back strength (p = 0.015), muscle endurance (p = 0.007), flexibility (p = 0.000), and balance (p = 0.018), in intervention group compared with control group.
Tooms et al. (1987) *(English)*USA	Randomised controlled study	n = 100; Control group(n = 49),intervention group (n = 51)	Viscoelastic insoles	No insoles	Low back pain and pain in lower extremities post work	Statistically significant peripheral shift in pain location from low back pain to pain in lower extremity (p = 0.02) and significant changes in duration of post-work pain (p = 0.04) and frequency of pain during the workday

(*continued on next page*)

Table 1 (*continued*)

First author (year), *(language)*, Country	Study design	Population:Student nurses*	Intervention	Comparison	Outcome of interest	Results
						(p = 0.02) in intervention group compared to controls.
Yazdani et al. (2014) *(English)*Iran	Quasi-randomised controlled study	n = 38; Control group(n = 19),intervention group (n = 19)	Laughter Yoga	No laughter Yoga	General health and physical disorders	statistically significant positive effect of intervention on general health in intervention group (p = 0.01), but no statistically significant difference in the control group (p = 0.33).

* Population: 'student nurses' unless stated otherwise, ** When available, p-values are given from the original study.

4.1. Interventions to improve the physical health

For this review, only 11 studies could be identified. The majority of the included studies focused on intervention programmes related to ergonomic training, aimed at reducing musculoskeletal disorders in student nurses. Overall, there was conflicting evidence for the effects of such curriculum-based training on musculoskeletal symptoms, while positive, negative and no effects were reported in the eligible studies (Table 1). Comparison of the studies reporting on the outcome 'back pain' (Table 2) showed that three out of five studies (Gladman, 1993; Moens et al., 2002; Videman et al., 1989) had an outcome in favour of the intervention, whereas one study favoured the control group (Hellsing et al., 1993) and one study (Svensson et al., 2009) showed no clear effect for neither the intervention group nor the control group. Therefore, the evidence for the effect of curriculum-based training on back pain is limited. Interventions with regard to safe patient handling (e.g. the use of proper ergonomic techniques) have been in the nursing curriculum for many years. It is surprising that there are so few intervention studies that support the rationale for this form of education for student nurses. In contrast, interventions aimed at reducing musculoskeletal disorders in registered nurses with multiple years of experience are numerous (e.g. Bartnik and Rice, 2013; Collins et al., 2004; Koppelaar et al., 2012; Nelson et al., 2003; Sharafkhani et al., 2016; Trinkoff et al., 2003). This indicates that additional research is needed in the field of intervention studies focusing on student and novice nurses.

4.2. Comparison with other studies

Next to the lack of eligible studies on dropout from the nursing profession or intervention studies among novice nurses, this review found no evidence for the effect of interventions in the educational setting on musculoskeletal symptoms among student nurses. This concurs with results from reviews looking at the effect of education in the primary prevention of musculoskeletal symptoms among other target populations. A review including 5525 workers in various workplace settings (including hospital/healthcare workers), found no effect of education in the primary prevention of low back pain (van Poppel et al., 2004). In a total of 18,492 workers in various workplace settings (including 1169 nurses), no evidence for the effectiveness of training with or without lifting equipment in the prevention of back pain or consequent disability was found (Martimo et al., 2008). In their systematic review, Richardson et al. (2018) found limited evidence for interventions, like patient lift systems, patient handling training, and multicomponent interventions, to prevent musculoskeletal injuries in nurses. Finally, a review that included 2194 nurses in various health care settings concluded that training and education alone is not sufficient for a decrease in musculoskeletal symptoms, but training and education in combination with an ergonomic intervention (i.e. use of additional mechanical or other aids) seemed to be effective (Bos et al., 2006). This indicates that training and education alone might not necessary influence the behaviour of students in practice. Possible solutions could be found in a combination of ergonomic training and education on one hand and practical/-behavioural interventions at the workplace on the other hand. This is in line with one of the included studies (Gladman, 1993) that acknowledged that nursing training plays an important role in the skills of nurses to lift/move patients, but noted that education on lifting/moving patients should not end in the classroom. Gladman (1993, p.50) also stated that "*Students require skilled, up-to-date supervision by qualified nurses*", but some students receive limited supervision and the attitudes of the qualified staff do little to promote safe practice.

4.3. Risk of bias in included studies

Current review did not identify any high quality studies. Furthermore, the eligible studies were quite old. The most recent was

First author (ref. no.)		Random sequence generation	Allocation concealment	Blinding of participants and	Blinding of outcome assessment	Incomplete outcome data	Selective outcome reporting	Other sources of bias	Conclusion
Costa et al. (2011)	O	?	?	-	-	?	?	-	High RoB
Gladman (1993)	NCT	-	-	?	?	+	-	-	High RoB
Hellsing et al. (1993)	NCT	?	?	-	?	?	?	-	High RoB
Kim and Park (2006)	RCT	-	-	-	-	-	?	+	High RoB
Moens et al. (2002)	NCT	-	-	-	-	+	?	?	High RoB
Stubbs et al. (1983) A)	O	-	-	-	-	+	-	-	High RoB
Stubbs et al. (1983) B)	NCT	-	-	-	-	+	-	-	High RoB
Svensson et al. (2009)	RCT	?	?	-	?	+	+	+	High RoB
Tooms et al. (1987)	RCT	+	?	-	-	?	?	+	High RoB
Troup and Rauhala (1987)	NCT	-	-	-	-	?	?	?	High RoB
Videman et al. (1989)	NCT	-	-	?	-	-	+	-	High RoB
Yazdani et al. (2014)	QCT	-	-	-	?	?	?	-	High RoB

Key	
RoB	Risk of bias
+	Low risk of bias
-	High risk of bias
?	Unclear risk of bias
NCT	Non-randomised controlled study
RCT	Randomised controlled study
QCT	Quasi-randomised controlled study
O	Observational study

Fig. 2. Assessment of the methodological quality of each study.

published in 2014, but most were published before 2000, indicating that this area has lacked attention in recent years.

The methodological quality of the studies compromises the evidence provided. Most included studies had small numbers of participants and the risk of bias was overall high (Fig. 2). Similar conclusions were drawn by Richardson et al. (2018), in their review on interventions to prevent and reduce the impact of musculoskeletal injuries among registered nurses. It is therefore justified to encourage better quality

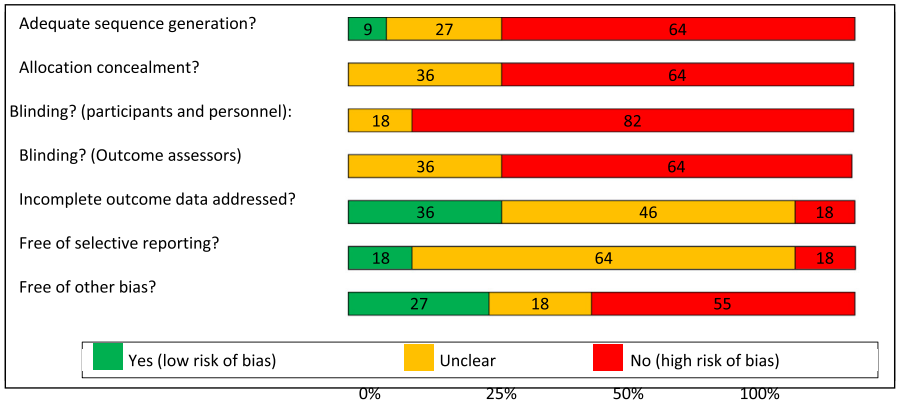

Fig. 3. Assessment of the methodological quality of each item: presented as percentages across all included studies.

(RCT) studies with sufficient numbers of participants, increased length of study duration and appropriate (cluster) randomisation, that provide evidence in the nursing student and novice nurses population.

We understand that aspects of an RCT, considered as the gold standard for studying effectiveness, can be unfeasible in an educational setting. The rationales for chosen designs other than RCTs, however, were not addressed in the included studies.

To increase the likelihood of success in a RCT, a feasibility or pilot study may be an essential stage in the project (Bowen et al., 2009; Eldridge et al., 2016). It may also be justified to consider alternative designs, such as a pragmatic stepped wedge cluster randomised design or a multiple baseline design (Schelvis et al., 2015).

4.4. Strengths and limitations of this review

The strengths of this review include a comprehensive electronic literature search, systematic review methods including double extraction of papers, and contact with authors to clarify data. The main concerns for the review arise from: firstly, the fact that the studies were not all RCTs and our choice to assess the methodological quality of the included studies using the Cochrane Risk of Bias (RoB) tool (modified) for quality assessment of RCTs. Since we were looking for the effect of interventions rather than associations, we decided to continue to use the Cochrane RoB tool for assessing RCT, despite the fact that the majority of included studies in this review were not RCT. The second concern was the decision to apply 'no language restrictions'; of the 11 studies, 9 were published in English, one was published in Portuguese (Costa et al., 2011) and another in Korean (Kim and Park, 2006). These latter studies were translated by means of Google translate. This may have had consequences as such translations are not always accurate. In order to improve accuracy, we translated the studies sentence by sentence in English and double checked it with another language (Dutch). Balk et al. (2012) formally evaluated the accuracy of Google Translate for the purpose of data extraction of non-English language articles. Data extraction was studied from ten RCTs in eight languages (including Portuguese and Korean). Balk et al. (2012) concluded that accurate extraction was possible for some articles in all languages, except for Chinese. The Portuguese translation yielded the most accurate extractions (Balk et al., 2012). Finally, in some studies it was difficult to retrieve the appropriate data due to poor presentation of the results. In these cases we had to recalculate the results to obtain accurate data for Table 2. Contacting the authors did not provide the required information as only one author responded (but with incorrect information).

5. Conclusions

This review indicates that there is little and inconsistent evidence for effective interventions to reduce dropout from the nursing profession/education nor the prevention of musculoskeletal symptoms among student or novice nurses. Further high-quality research is required to ascertain the development, evaluation and sustainability of such interventions and to determine the long-term benefits of these interventions with regard to dropout/retention and the reduction of musculoskeletal complaints in this population. Such research should contain sufficiently large samples and adequate follow-up periods. To evaluate the relation between musculoskeletal problems and dropout from nursing education or the nursing profession within two years after graduation, it is important that these outcomes are reported as well in future studies.

Disclaimer

The funding sources had no involvement in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

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Ethical approval

Not applicable.

CRediT authorship contribution statement

Jos H.A.M. Kox: Conceptualization, Formal analysis, Methodology, Writing - original draft, Writing - review & editing. **Ellen J.M. Bakker:** Formal analysis, Writing - review & editing. **Sita Bierma-Zeinstra:** Writing - original draft, Writing - review & editing. **Jos Runhaar:** Supervision, Writing - review & editing. **Harald S. Miedema:** Writing - original draft, Writing - review & editing. **Pepijn D.D.M. Roelofs:** Conceptualization, Supervision, Funding acquisition, Project administration, Writing - review & editing.

Declaration of competing interest

All authors declare that they have no competing interests.

Table 2
Change in prevalence of back pain before and after an intervention.

First author (ref. no.)	Experimental group				Control group			
	Total no. of students	No. with back pain *before* intervention (%)	No. with back pain *after* intervention (%)	Change in prevalence of back pain	Total no. of students	No. with back pain before intervention (%)	No. with back pain after intervention (%)	Change in prevalence of back pain
Gladman (1993)	36	19(53%)	13*(36%)$_{*\text{After 1.5 years}}$	−17%	44	12(27%)	20*(46%)$_{*\text{After 2 years}}$	+19%
Hellsing et al. (1993)	19	10(55%)	9*(50%)$_{*\text{After 1 year}}$	−5%	33	22(59%)	16*(45%)$_{*\text{After 1 year}}$	−14%
Moens et al. (2002)	100	59(59%)	67*(67%)$_{*\text{After 1 year}}$	+8%	124	69(56%)	90*(73%)$_{*\text{After 1 year}}$	+17%
Svensson et al. (2009)	372	148(38%)	139*(37%)$_{*\text{After 1 year}}$	−1%	266	119(43%)	110*(41%)$_{*\text{After 1 year}}$	−2%
Videman et al. (1989)	87	57(64%)	45*(56%)$_{*\text{After 1 year}}$	−8%	113	50(47%)	61*(58%)$_{*\text{After 1 year}}$	+11%

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nepr.2020.102772.

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Corrigendum to: "Effective interventions for preventing work related physical health complaints in nursing students and novice nurses: A systematic review" [Nurse Educ. Pract. 44 (2020)102772]

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The authors regret that there are incorrect numbers included in our Table 2 (Kox et al., 2020). This is the original table. The yellow highlighted text should be altered:.

First author (ref. no.)	Experimental group				Control group			
	Total no. of students	No. with back pain *before* intervention (%)	No. with back pain *after* intervention (%)	Change in prevalence of back pain	Total no. of students	No. with back pain before intervention (%)	No. with back pain after intervention (%)	Change in prevalence of back pain
Gladman (1993)	36	19 (53%)	13* (36%) *After 1.5 years	-17%	44	12 (27%)	20* (46%) *After 2 years	+19%
Hellsing et al. (1993)	19	10 (55%)	9* (50%) *After 1 year	-5%	33	22 (59%)	16* (45%) *After 1 year	-14%
Moens et al. (2002)	100	59 (59%)	67* (67%) *After 1 year	+8%	124	69 (56%)	90* (73%) *After 1 year	+17%
Svensson et al. (2009)	372	148 (38%)	139* (37%) *After 1 year	-1%	266	119 (43%)	110* (41%) *After 1 year	-2%
Videman et al. (1989)	87	57 (64%)	45* (56%) *After 1 year	-8%	113	50 (47%)	61* (58%) *After 1 year	+11%

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The highlighted text in the table above needs to be altered into the following:

Svensson et al. (2009)	372	148 (39%)	n/a* (50%) *After one year	+11%	266	119 (44%)	n/a* (53%) *After one year	+9%

This effects the text under 4.1 "Interventions to Improve the Physical Health". The following lines in the original article read:

Comparison of the studies reporting on the outcome "back pain" (Table 2) showed that three out of five studies (Gladman, 1993; Moens et al., 2002; Videman et al., 1989) had an outcome in favour of the intervention, whereas one study favoured the control group (Hellsing et al., 1993) and one study (Svensson et al., 2009) showed no clear effect for neither the intervention group nor the control group.

This text needs to be altered into:

Comparison of the studies reporting on the outcome "back pain" (Table 2) showed that three out of five studies (Gladman, 1993; Moens et al., 2002; Videman et al., 1989) had an outcome in favour of the intervention, whereas two studies favoured the control group (Hellsing et al., 1993; Svensson et al., 2009). In two studies (Moens et al., 2002; Svensson et al., 2009), the prevalence of back pain increased in both the intervention and control group, with the increase in the study by Moens et al. (2002) being 9% larger in the control group. In the study by Svensson et al. (2009) however, the increase was larger in the intervention group, but the difference was minimal at 2%. Studies did differ on the obtained pain measurement scales and time points.

The authors would like to apologise for any inconvenience caused.